TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 495

DEVICE FOR THE AUTOMATIC CONTROL OF AIRPLANES

By Alfred Gradenwitz

From Der Motorwagen, March 31, 1928

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DEVICE FOR THE AUTOMATIC CONTROL OF AIRPLANES.*

By Alfred Gradenwitz.

Franz Drexler, the inventor of the rudder-angle indicator, has been working for almost two decades on the problem of the automatic control of airplanes. At the sixteenth session of the W. G. L. (Scientific Society for Aeronautics) in Wiesbaden, he announced that he has finally found a practical solution. His invention can be installed with four screws in any airplane. It has three switch buttons, with which the three-part automatic control can be switched on or off in whole or in part, thus leaving the controls to be operated by hand or foot.

Drexler succeeded in mounting the three necessary controls (aileron, rudder and elevator) in three separate boxes and in combining them in one block with the hand and foot controls (Fig. 1). The automatic elevator control is on the left. On the opposite side is the aileron control, and both are connected by a plate on which the rudder control is centrally located (Fig. 6).

In order to simplify and cheapen its construction, the inventor has endeavored, from the beginning, to use, in so far as possible, like structural parts for all three controls.

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*"Selbststeuerung für Flugzeuge," from Der Motorwagen, March 31, 1928, pp. 204-206.

Since, in each case, the steering way is relatively short, only 10-25 cm (4-10 in.), the transmission gear of the automatic-control mechanism had to exert a strong pull on the corresponding controls. For the intermediate control a purely electric transmission was therefore chosen instead of the hydraulic and pneumatic devices previously tried by Drexler.

Each individual control mechanism has a special contact-making device by which a reversing motor is set rotating right or left (Fig. 2). The rotation of the motor armature is transmitted to a drum in the ratio of about 1 : 160, which is identical in principle with a lifting magnet. Inside the drum driven by the motor there is a rim winding, which, during the passage of the electric current, attracts the armature plate, which is held down by springs, and consequently the control cable connected with the corresponding automatic control. The return mechanism of the releasing device is installed on the opposite side of the magnet coupling (likewise in high gear). This is the case, however, only in the elevator and aileron controls, the rudder being controlled by an electric three-phase, rapidly rotating gyroscope (20,000 revolutions, 333 periods). In the latter case, for ostensible reasons, no return is necessary. The gyroscope, held by springs in a certain zero position, soon becomes neutral, after contact is made, and, after completed precessional motion, returns automatically to its zero position (Fig. 3). On the contrary, a return is absolutely

necessary for the elevator and aileron controls, where pendular devices serve as releasing organs.

The pendulum, which serves to release the elevator control, is of peculiar construction, but the one used for the aileron control is a simple gravity pendulum. After long experimentation, Drexler constructed a reversing motor, which is used in the same form for all three controls and whose armature is provided at both ends with a commutator and has a double continuous winding, so that only a single contact is required on either the right or left, in order to reverse the motor while running at full power with about 3000 R.P.M.

The direct current for the reversing motors (as likewise the alternating current for the gyroscope) is produced by a windmill-driven generator.

Of especial importance, as was rightly recognized by Drexler, is another device used with each control mechanism, which limits the possible deflection to the admissible amount in all three cases. If, for example, the strongly working automatic rudder control could force the rudder beyond the admissible limit, the control cables might break, thereby seriously endangering the airplane.

No pendular releasing device was considered for the rudder control. Though Drexler is now using a neutral suspended gyroscope (which is held in the middle position by springs and constantly tends to assume this zero position, but, with every de-

viation of the airplane from its course and as a result of its precessional motion, makes a contact and thus controls the corresponding motor), it by no means follows that other devices (e.g., a gyroscopic compass, an earth-inductor compass, or a self-registering radio compass) might not be used.

The pendulums provided as releasing devices for the elevator and aileron controls must (especially for the former) be adapted to the characteristics of the airplane. In Drexler's present device this can be accomplished by the simple adjustment of a nut.

An ordinary, somewhat damped, lead gravity pendulum may be used for the aileron control. The regulation of the elevator control is more difficult. The releasing device must be adjusted to the flight attitude, as well as to the speed of the airplane, and, under some conditions, even to the revolution speed of the engine. The inventor solves this complicated problem by using a bent glass tube (Fig. 4) half-full of mercury, one end of this tube being connected with an ordinary Pitot tube and the other end with a rotary blower. The weight of the pendular support is reduced to a minimum, so that the weight of the pendulum is essentially the weight of the mercury. The mercury is displaced by the Pitot tube according to the speed of the airplane, thereby shifting the center of gravity of the pendulum. The same thing happens when the revolution speed of the engine changes. In this way the automatic elevator control can

be made to correspond to the three factors, attitude, speed of airplane and revolution speed of engine.

Since, with increasing dimensions of the airplanes, the distance between the pilot's and commander's posts is unavoidably increased, provision must be made for observing, from any desired point, the operation of the automatic control in all its parts. For this purpose Drexler has made provision for the use of as many auxiliary indicating devices as may be needed (Fig. 5).

Moreover, provisions have been made for correcting the control mechanism at any time. For this purpose, Drexler uses a pair of solenoids, which are coupled with each releasing device and have a damping effect with their iron cores, even when the solenoids are not in the circuit (Figs. 2-3). Provision is thus made for the desirable stabilization of the releasing devices.

The automatic control, as shown in Figure 6, may well prove to be of great importance for aviation. Drexler believes that, before long, some such device will be required on every airplane. As he graphically expressed it at the Wiesbaden session of the W. G. L., the pilot of a commercial airplane equipped with his invention, "setting out from Tempelhof Field (Berlin) for Hamburg, can, after attaining the desired altitude and setting his course with due allowance for drift, enter the dining room and be served with a cutlet, and two hours later arise from his

seat with the remark 'In ten minutes we will be in Fuhlsbuttel' and behold, it is so."

On an airship, where there are no ailerons to provide for, the problem is still simpler.

Translation by Dwight M. Miner,
National Advisory Committee
for Aeronautics.

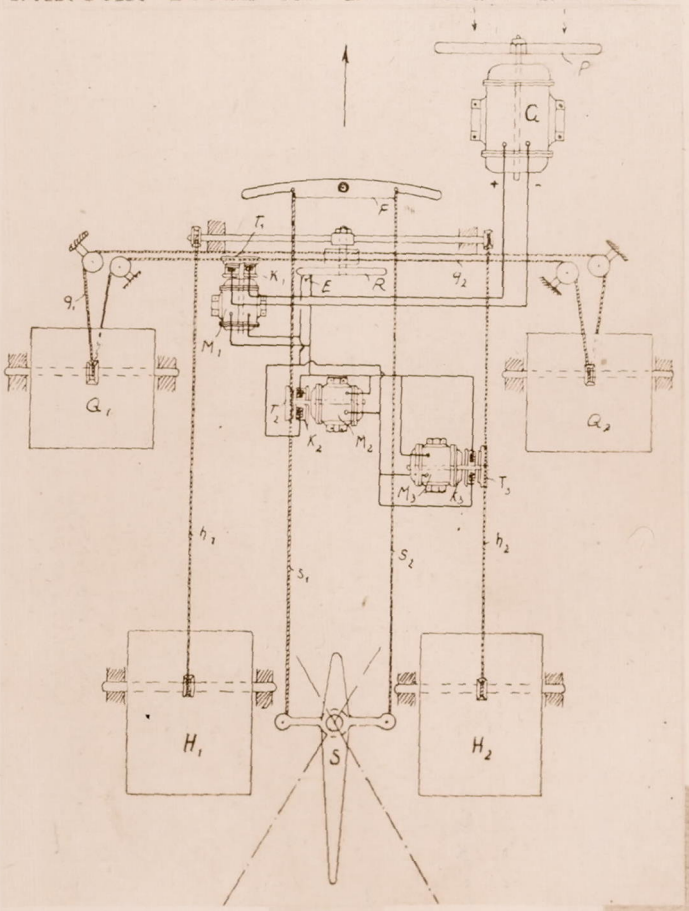

Fig.1

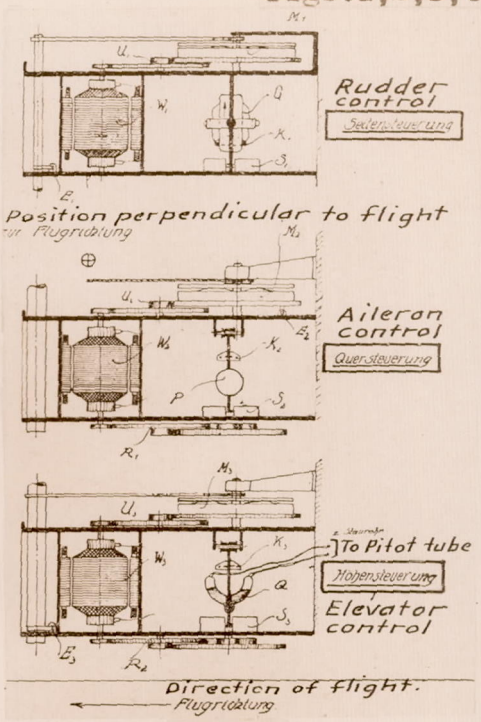

Fig.2

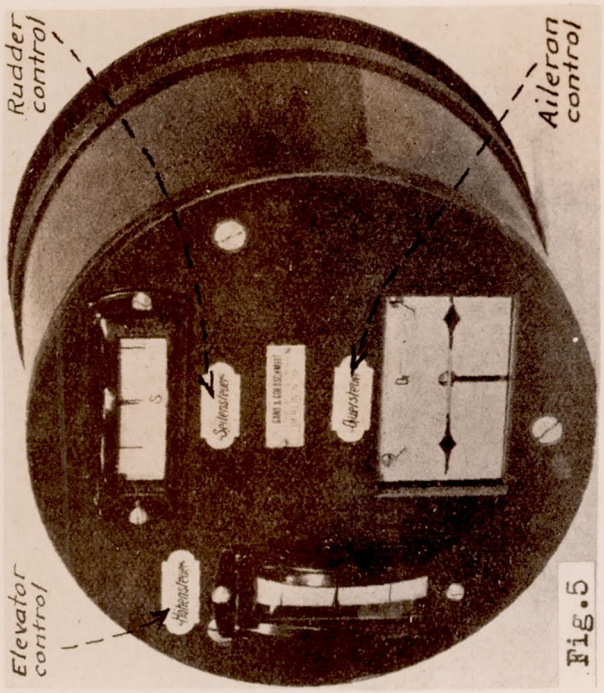

Fig.5

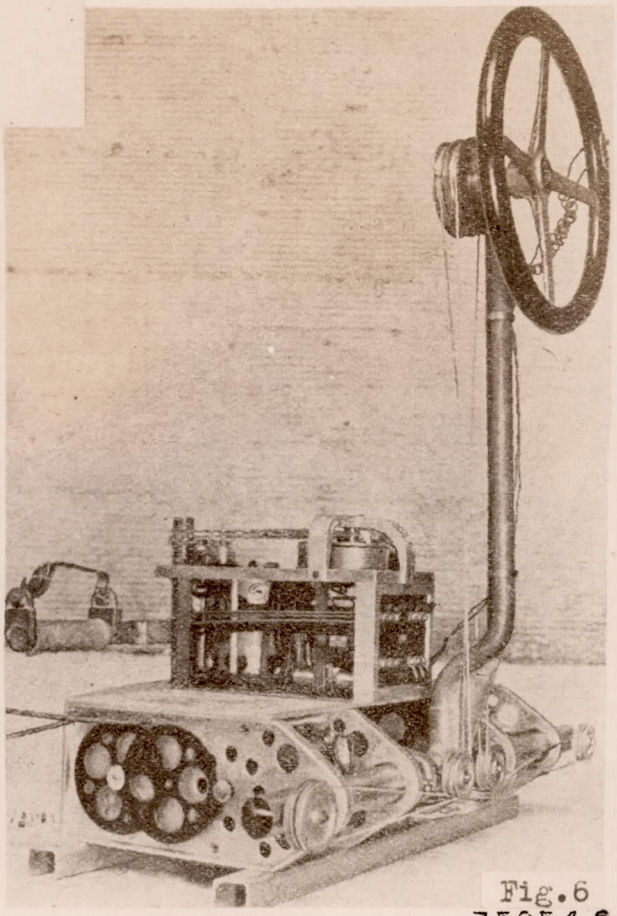

Fig.6

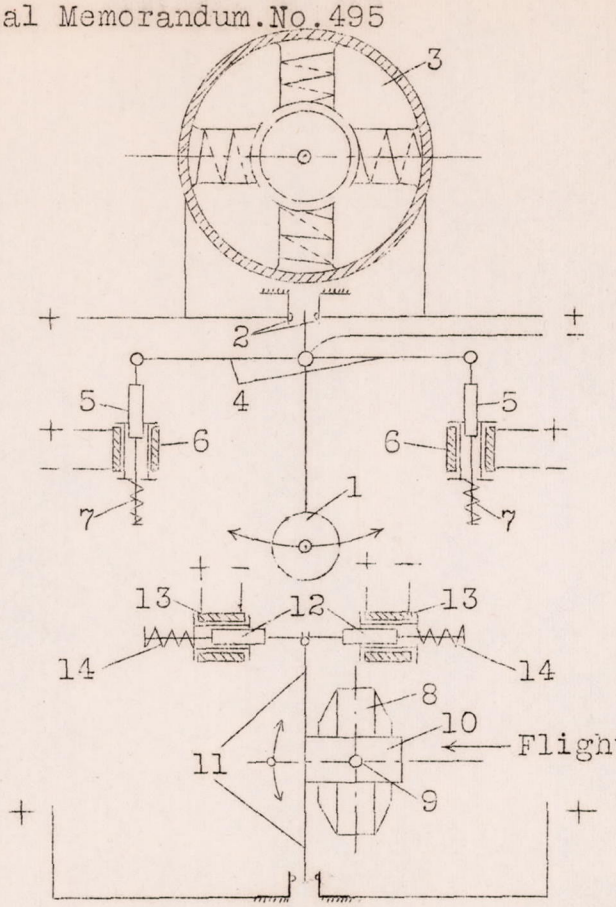

Fig.3

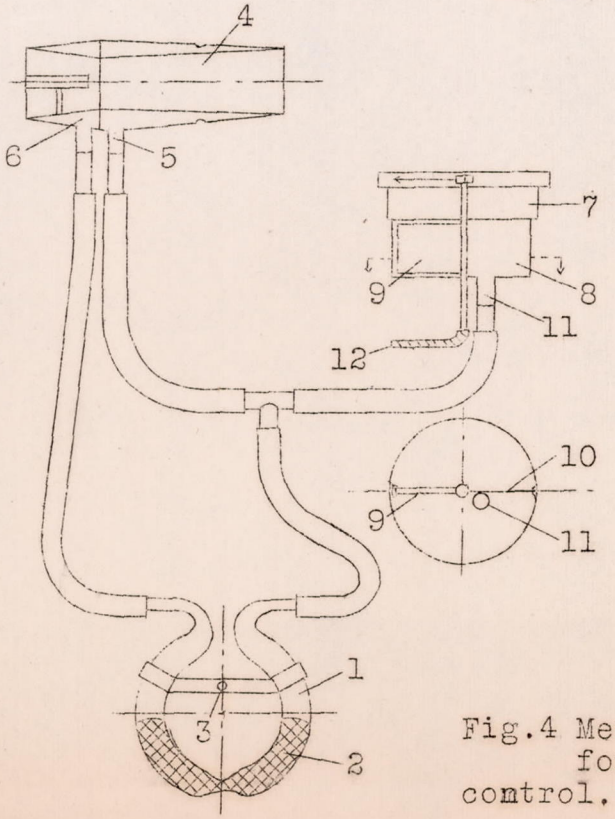

Fig.4 Mercury pendulum for elevator control.